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Effects of Silvicultural Systems and Vegetation Control on Tree Growth in a Coastal Montane Ecosystem: Seven Year Results

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Strategic Importance

Local and global concerns over clearcut-based silvicultural practices and increased awareness of the need to sustain non-timber resource values has placed pressure on industry and government to consider new approaches to managing forests. Consequently, a variety of overstory retention (silvicultural systems) are being studied as alternatives to clearcut harvesting. Alternative systems must satisfy long-term forest resource management objectives, must be operationally feasible, economically viable, ecologically sound and socially acceptable. The long-term effects on forest dynamics, soils, and microclimate resulting from various silvicultural systems will impact forest management over a rotation and beyond.

After seven years, volume growth of western hemlock and amabilis fir is faster in Silvicultural Systems with the least retained overstory.

The Montane Alternative Silvicultural Systems Study

The Montane Alternative Silviculture Systems (MASS) study on Vancouver Island focussed on potential inconsistencies in periodic annual growth of conifer regeneration following clearcut harvesting of old growth at high elevations. The study was established to find out to what extent these inconsistencies were caused by unfavourable microclimate, competing vegetation, and nutrient availability on large clearcuts, and to find out which harvesting method would create a more favourable environment for regenerating cut-over areas. The MASS study evaluated four silvicultural systems (treatments) representing a range of overstory removal, as well as an old growth control. These systems were chosen to provide a wide range of light, temperature, evaporative demand and moisture in the test areas. Briefly, the systems are described as follows:

- The shelterwood system retained about 200 standing trees per hectare;
- The green tree retention system retained 25 standing trees per hectare;
- The patch cut system removed all trees in three 1.5 ha patches within each treatment block (treatment blocks were approximately 9 ha), leaving alternating strips between the patch cuts;
- The clearcut system removed all standing trees on 69 ha; and,
- No trees were removed from the 20-ha old-growth control.

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In this Note, we summarize our own results from planting trials involving western hemlock and amabilis fir seedlings, and discuss some results from a related study, conducted by B.G. Dunsworth and J.S. Sandford of Weyerhaeuser Ltd.

Western hemlock [1+ 0 - 415] seedlings and Abies amabilis [1+ 0 - 313] seedlings were planted in each treatment area, in logged but otherwise undisturbed soils, adjacent to forwarding corridors. The two species were alternated within rows. Seedling height and basal diameter were measured at time of planting then annually at the end of each growing season for the first five years, then again at the end of year seven.

In our trials, competing vegetation was removed manually during each growing season. In the related Weyerhaeuser trials, growth was compared in areas where vegetation was not controlled and in areas where vegetation was controlled using a herbicide (glyphosate). Glyphosate was applied in each of the first four growing seasons with a backpack sprayer. The cumulative amount of active ingredient applied over four years was 4.59 kg/ha.

Results

Differences in soil moisture regime, depth of forest humus between and within treatments and vegetation competition affected seedling performance.

Seedling Survival

Survival of both western hemlock and amabilis fir after seven growing seasons was highest in the patch cut treatment (98%) followed by the clearcut (94%) and the green tree retention treatment (92%) and was lowest in the shelterwood treatment (87%) (Figure 1).

Seedling Growth

In the first three years, the average stem volume of western hemlock in the patch cut treatment was 50% greater than that in the clearcut, nearly double that in green tree retention treatment and nearly four times that in the shelterwood treatment . Over the next few growing seasons, growth rates in the patch cut treatment declined compared with the other treatments. After 7 years, the average stem volume of western hemlock in the patch cut treatment was the same as that in the clearcut treatment, was only about 30% greater than in the green tree retention treatment and remained about four times that in the shelterwood treatment. (Table 1)

For the first three growing seasons, volume growth of the amabilis fir in the clearcut and patch cut treatments was nearly identical. Similarly, the growth was nearly identical in the green tree retention and shelterwood treatments. After the seventh growing season, the average stem volume was greatest by far in the clearcut, followed by the patch cut, green tree retention, and shelterwood treatments.

Stem volume increased sharply between years five and seven (Table 1).

Stem volume increased faster in western hemlock than in amabilis fir during the first five years. Between years five and seven, however, volumes increased faster in amabilis fir –volumes at year seven were 3.25 times greater than at year five. Western hemlock increased by a factor of only 2.5 during the same period.

Control of Competing Vegetation

Competing vegetation had a major influence on the growth response of the conifer seedlings under the different silvicultural treatments.

In our own trials, where competing vegetation was controlled manually, fireweed (*Epilobium angustifolium*) was especially abundant and vigorous in the clearcut, partial cut and green tree retention treatments, and was by far the major competitor with conifer seedlings. In the shelterwood treatment, fireweed occurred mainly in forwarding corridors and in small openings while Vaccinium seemed to be more common beneath a relatively dense canopy.

In the study by Dunsworth and Sandford (2000), stem volume of western hemlock was assessed after five growing seasons in an area where competing vegetation was controlled with glyphosate and in an area where competing vegetation was not controlled. Their results are compared with our own results obtained with manual vegetation control in Table 2.

Manual control methods involved clipping or pulling all competing vegetation within plantations and a surrounding buffer zone of about 1 to 2 m during each growing season. This technique was effective in removing the aboveground biomass but left many root systems relatively undisturbed. Consequently, there was often rapid re-colonization of the sites. Manual vegetation control required treatment each growing season and careful monitoring.

In contrast, the herbicide eliminated competing vegetation outright and was effective in inhibiting its regrowth.

Management Implications

- Variation in light levels and site differences in the different silvicultural systems affected seedling survival and performance. These same factors also directly affected the abundance, vigor and species of competing vegetation.
- Although average stem volume for western hemlock was initially greater in the patch cut, after seven growing seasons, stem volumes in the clearcut and patch cut treatments were similar. Seedlings in the green tree and shelterwood treatments had considerably less stem volume growth.

Table 1. Average stem volume (cm^3) of amabilis fir and western hemlock seedlings growing on undisturbed soils in four treatments with manual vegetation control.

Treatment	amabilis fir			western hemlock		
	3 years (1996)	5 years (1998)	7 years (2000)	3 years (1996)	5 years (1998)	7 years (2000)
Clearcut	13	97	390	60	600	1750
Patch cut	12	78	230	90	825	1750
Green tree retention	07	57	180	50	490	1350
Shelterwood	05	40	110	25	200	480

Table 2. Average stem volume (cm^3) of western hemlock seedlings after five years following vegetation control.

Treatment	Control * (no vegetation removal)	Manual vegetation removal	Vegetation removal with a herbicide*
Clearcut	450	600	1250
Patch cut	340	825	750
Green tree retention	490	490	940
Shelterwood	150	200	350

* Control and *herbicide data from Dunsworth and Sandford (2000)

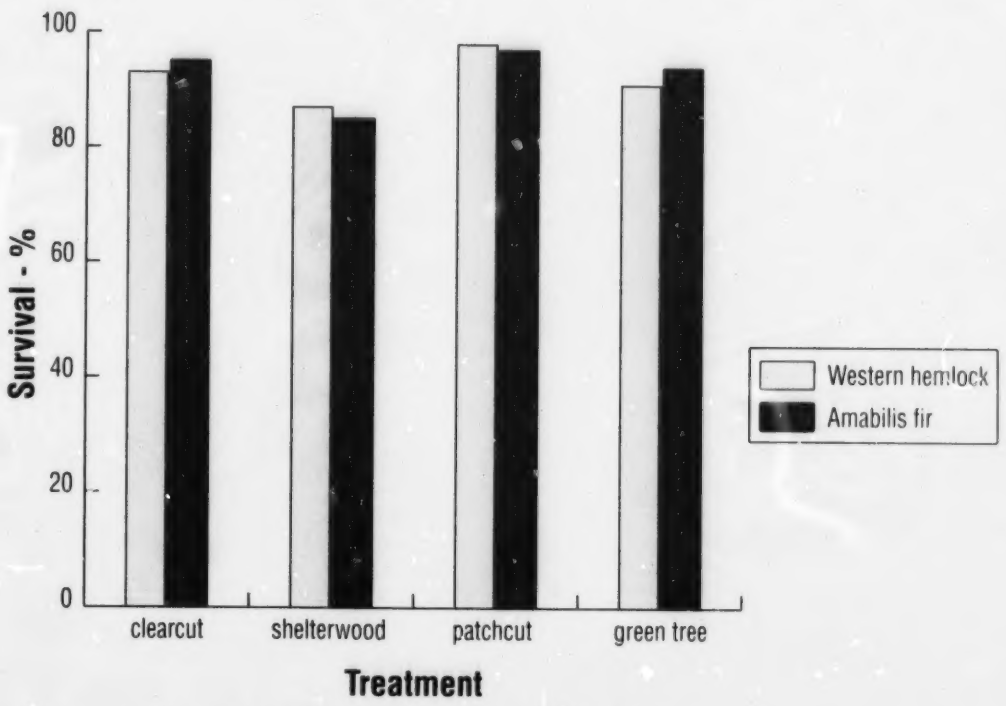

Figure 1. Survival of western hemlock and Abies amabilis seedlings on undisturbed soils after 7 years (vegetation controlled normally).

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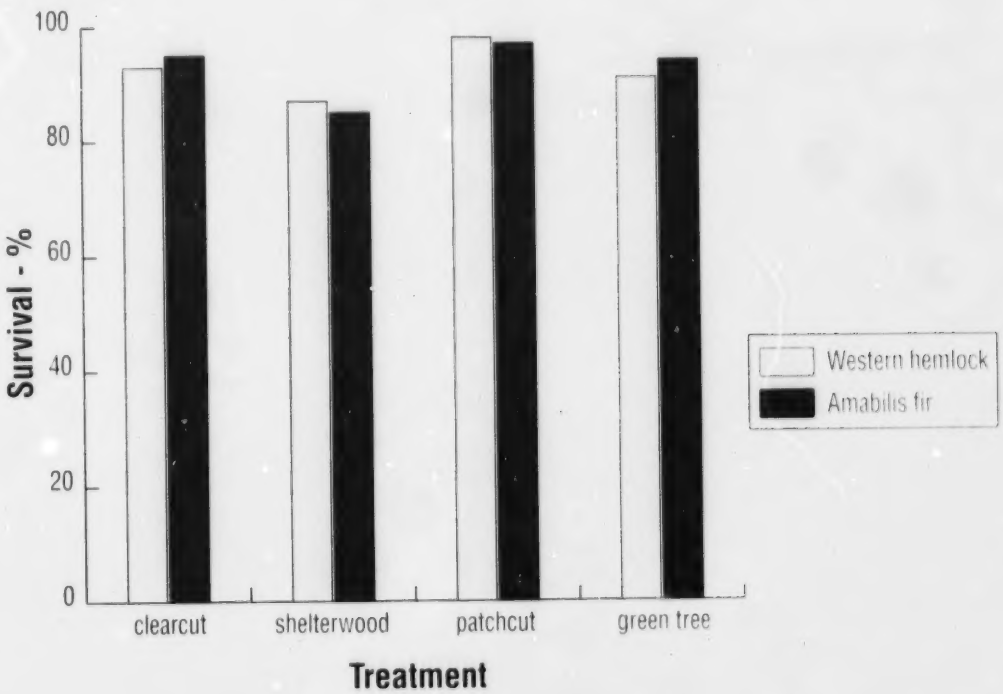

Figure 1. Survival of western hemlock and Abies amabilis seedlings on undisturbed soils after 7 years (vegetation controlled normally).

- After seven growing seasons, stem volume for amabilis fir was highest in the clearcut treatment, followed by the patch cut, green tree retention, and shelterwood treatments.
- Stem volumes for both species were lowest in the shelterwood treatment.
- Over seven growing seasons, there was no evidence of inconsistencies in growth or variable periodic annual growth of planted seedlings within any of the silvicultural systems.
- Control of competing vegetation in plantations, till seedlings are free to grow, is critical for good seedling performance.
- Herbicide application eliminated both above and below-ground portions of the plant and was more effective in promoting seedling growth than manual vegetation control.
- After five growing seasons, average stem volumes of western hemlock, in areas treated with herbicide, were nearly double the stem volumes in areas where manual control was used, except for the patch cut treatment.
- It is not possible to predict long-term growth trends from these early data with any confidence. However, if present trends continue, long-term tree growth may be reduced in those silvicultural systems where overstory was retained.

Additional Reading

Beese, W.J. 1995. Montane Alternative Silvicultural Systems (MASS) Introduction and Objectives. Pages 3-8 *in* J.T. Arnott, W.J. Beese, A.K. Mitchell, and J. Peterson, editors. Montane alternative silvicultural systems. Proceedings of a Workshop held June 7-8, 1995 in Courtenay, British Columbia. Forestry Canada, Pacific Forestry Centre, FRDA Report 238. Copublished by the British Columbia Ministry of Forests.

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